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Linkage model between sustainable consumption and household waste management

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Abstract

The growth of population increases not only the basic needs of human but also the use of natural resources. Household consumption pattern gives impact to economic growth, social condition, and environmental quality. Jakarta as the capital of Indonesia (the 4th biggest most populous country in the world) still has waste management problems. East Jakarta area has the biggest issue of unmanaged waste (2,430 m^3/day) and Duren Sawit District has the biggest number of households or families (94,862 KK). This paper analyzed how the household consumption pattern links to the household waste management. The Spearman's Rho Correlation analysis showed that there are correlations between household consumption (for food and non-food) with the application of the 3R principles (Reduce, Reuse, and Recycle). To build the linkage model between sustainable consumption and household waste management, this research used the system dynamics analysis. The result shows that the waste management system now in Jakarta is not sustainable, and it increases the unmanaged waste. To reduce the unmanaged waste, the model of inside (functional intervention through green motivation and green lifestyle) and outside (3R-structural intervention) could be applied.

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1. Introduction

Jakarta as the capital city of Indonesia is the most densely populated (14,469 people/km2), and it still has waste management problems. This special province is divided into five administrative district areas: Central Jakarta, East Jakarta, West Jakarta, South Jakarta, and North Jakarta. East Jakarta has the biggest problem on unmanaged waste management system (2,430 m3/day) compared to other district areas. Unmanaged waste can reduce the quality of the environment, social, and economic aspects. Household waste is generated from the household consumption. Based on the household consumption expenditure data from Statistical Office in 2011 and 2012, it is found that people in Jakarta consumed more on non-food products (66.24% and 63.01%) than food products (33.76% and 36.99%). It means that the increase of the household income will shift the consumption pattern from food products into non-food products. This phenomenon follows the Engel's Law with assumption that the household consumption preferences are at the same level.

The change of household consumption pattern will change the waste volume and the waste characteristics or composition. It is caused by the packaging materials that they use. Many factors influence the volume of the household waste; for example, the application of the 3R principle (Reduce, Reuse, and Recycle), the infrastructure, the law on waste management system, the packaging materials, population number, household income and household consumption pattern. The characteristic of the household waste can be divided into two major categories: organic and inorganic waste. Organic waste comes from plants and animals, food scraps, and yard trimmings. Inorganic waste is from man-made items such as plastic, paper, glass, and metals. Organic waste is easier to decompose than inorganic waste.

In order to explore more about the correlation between household consumption pattern and the household waste, this study used both qualitative approach and quantitative data. It has two main objectives: (a) to identity the household consumption pattern and (b) to analyze the linkage model between sustainable consumption and household waste management system. The final goal is to find the solution to reduce the unmanaged waste.

2. Methodology

The respondents were selected through simple random sampling method. To gather the information regarding the household consumption level, this research used the expenditure approach because there was no available data for household income level in Indonesia. The questionnaires were based on the basic needs triangle by Abraham Maslow and the consumer behavior theory (the internal and external factors). The variables and the sub-variables are: (a) motivation, including the needs value and the usage value; and (b) lifestyle, including the influence by others and advertisement. We used the Likert scale (options 1-5). We asked about the demographic, economic, socio-culture, and environmental aspects. An in-depth interview was conducted at the four areas at Duren Sawit District that already applied the 3R principle (based on the Sanitation Department Report, 2009). To get the data for the statistical analyses using Spearman's Rho Correlation, this research used Slovin formula (100 KK) and 8 KK at the 3R-applied areas. The housing area was divided into two categories: unorganized and organized housing areas. It is related to the social interaction among people, the product information among them, and waste management system. Table 1 shows the housing areas criteria.

For people in the unorganized housing area, their houses are relatively small and they are close with each other in the neighborhood. During the social interaction, they talk about new products (food and non-food). It becomes informal advertisement media. Because the area is packed, they do not have any trash bin. They put their trash in a plastic bag (they hang it up in front of their front door), and the sanitation officer will carry their waste bag using a wheeled cart. In the organized housing area, the sanitation officer uses a motor vehicle to carry the waste every other day.

Table 1. Housing Area Characteristics

Criteria	Unorganized Housing Area	Organized Housing Area
House Size	Small	Medium & Big
Trash Bin	Not Available	Available
Distance	Close	Far
Income	Low	Medium & High

East Jakarta has ten district areas: Pasar Rebo, Ciracas, Cipayung, Makasar, KramatJati, Jatinegara, Duren Sawit, Cakung, Pulo Gadung, and Matraman. Duren Sawit District has the highest number of household (Population Census, 2010), that is, 94,862 households or heads of family (KK). Duren Sawit District has seven villages or sub-districts: Pondok Bambu, Duren Sawit, Pondok Kelapa, Pondok Kopi, Malaka Jaya, Malaka Sari, and Klender. Therefore, the 100 KK spread on these seven villages. The hypothesis is there is correlation between the household consumption (food and non-food) and the household waste management.

To build the system dynamics modelling, this research uses the causal loop diagram (CLD) starting from loop balancing-B1 in which the increase of the household waste will increase the unmanaged waste. This makes people at Duren Sawit District call the sanitation officer to carry the unmanaged waste, and it results in more frequency to carry the household waste. The phenomena that happens now is not sustainable because the decreasing number of the unmanaged waste does not come from the internal side of the people. The intervention (loop reinforcing-R1) on the model comes from the green motivation and green lifestyle. This loop can reduce the unmanaged waste and becomes more sustainable in the future.

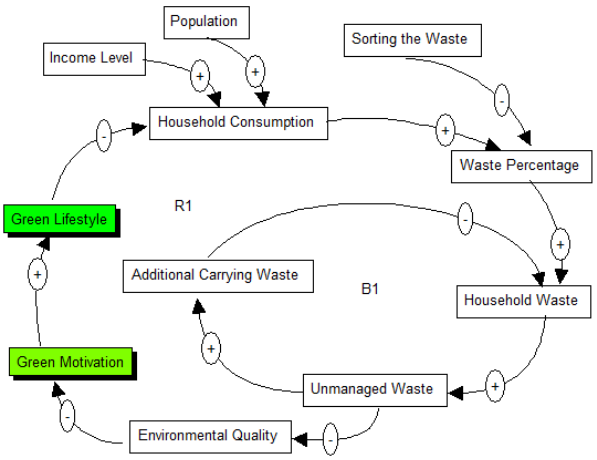

Fig. 1. Business as Usual (BAU) for Waste Management System
Source: System Dynamics Analysis using Powersim, 2014.

3. Results and Discussion

The household goods are categorized into two groups. *First*, food products such as rice, yam/cassava/maize, fish, meat, eggs/dairy, vegetables, fruits, sugar/coffee/tea, cooking oil/spices, beverages, tobacco/betel, and other food stuff/beverages.*Second*, non-food products such as clothes/shoes/hats, party needs/ceremonies (not including facilities for home/transportation/telecommunications, tax/insurance/savings, education services, security services/household workers, and health service/physician). The type of job for people at Duren Sawit District is on

the service type, but there is no data regarding the specific job that they have. The Spearman's Rho Correlation result summary can be sees in Table 2 below:

Table 2. Spearman's Rho Correlation Results

P<0.05, bermakna			Motivation				Lifestyle					
Variables		Household Income	Consumption		Needs Value		Usage value		Influenced by others		advertisement	
			food	Non-food	food	Non-food	food	Non-food	food	Non-food	food	Non-food
Household income			0.083	0.000*	0.612	0.981	0.381	0.612	0.132	0.040*	0.457	0.241
Consumption	Food			0.013	0.285		0.266		0.010*		0.624	
	Non-food					0.002*		0.977		0.698*		0.544
Motivation												
Needs value	Food											
	Non-food											
Usage value	Food					0.001*						
	Non-food					0.001*						
Life-style												
Influenced by others	Food						0.003*				0.000*	
	Non-food											0.000*
Advertisement	Food						0.000*					
	Non-food											
Actualization	Food											
	Non-food											
Product Choices	Food											
	Non-food											
Waste (kg)												
Prinsip 3R												
Reduce	Food											
	Non-food											
Reuse	Food											
	Non-food											
Recycle	Food											
	Non-food											
Frek. Belanja												

Source: Spearman's Rho Correlation using SPSS, 2014.

Table 2. Spearman's Rho Correlation Results (cont.)

p<0.05, bermakna

Variables		Actualization		Product Choices		Waste (kg)		Prinsip 3R						Frek. Belanja
								Reduce		Reuse		Recycle		
		food	Non-food	food	Non-food	food	Non-food	food	Non-food	food	Non-food	food	Non-food	
Household income		0.248	0.003*	0.122	0.447	0.000*		0.799	0.125	0.745	0.539	0.870	0.936	0.938
Consumption	**Food**	0.072		0.940		0.165		0.157		0.681		0.668		
	Non-food		0.918		0.980		0.015*		0.957		0.435		0.278	
Motivation														
Needs value	**Food**													
	Non-food													
Usage value	**Food**													
	Non-food													
Life-style														
Influenced by others	**Food**	0.000*												
	Non-food													
Advertisement	**Food**													
	Non-food													
Actualization	**Food**													
	Non-food													
Product Choices	**Food**													
	Non-food													
Waste (kg)														
Prinsip 3R														
Reduce	**Food**													
	Non-food											0.020*	0.010*	
Reuse	**Food**													
	Non-food													
Recycle	**Food**												0.050*	
	Non-food													
Frek. Belanja														

Source: Spearman's Rho Correlation using SPSS, 2014.

Based on the statistical analysis, the household consumption (non-food) has correlation with household income with the p-value is 0.000 (< 0.05). This result is the same as the Jakarta consumption pattern that has already shifted from food into non-food because of the increase of household income. This consumption will affect the household waste especially from the packaging. Theoretically, the food consumption comes from natural products (fruits and vegetables), and the waste will become organic waste that can be decomposed naturally. Meanwhile, non-food consumption includes processed foods packaged in such materials as plastic, paper, glass/metal, and etc that cannot be easily decomposed naturally, and it thus needs more waste management treatment. Therefore, people need to increase their green motivation (consumption that not only considers the price and quantity variabels but also the environmental value) and change the behavior into green lifestyle (more green product advertisement).

The household income has correlation with people's lifestyle, especially the influence from other people on their non-food consumption. Based on the Spearman's Rho Correlation the p-value is 0.0040 (< 0.05). Based on an in-depth interview, the respondents shared their social life about this matter. Related with household waste, people in the unorganized housing area go to the closest market every day, and they felt happier when carrying more plastic bags. The value that we can sense here is that people feel better by consuming more. On the consumer behavioral theory, this value is called prestige. In the developing country like Indonesia, this plays an important role. Table 2

shows that household income has correlation with the actualization of consumption of non-food products (p-value is 0.003 < 0.05). This paper highlights the household waste (around 0,75 kg/person/day). This number is close to the Standard National Indonesia (SNI) for the household waste volume for the big city or metropolitan area. The household waste is predicted to increase as the household income increases.

For the motivation on consumption for food and non-food, they have correlation with the usage value but not with the needs value. For the lifestyle, it has correlation with consumption for food and non-food. Motivation variable is more internal than the lifestyle variable because it comes from the inside factor of the consumer The intervention can be in internal side (through green motivation and green lifestyle) and external side (advertisement media). This paper will not discuss much about the producer side because it is outside of the research scope.

In addition to the consumption behavior analysis, this research observed the markets from the traditional market, mini-market, and the supermarket. The map below shows the location of the temporary landfills and the housing area at Duren Sawit District. Temporary landfills (TPS) is a place for placing the waste only temporarily. Based on the interview with the Sanitation Department staff at Duren Sawit District, it was learned that there 28 temporary landfills locations in this place.

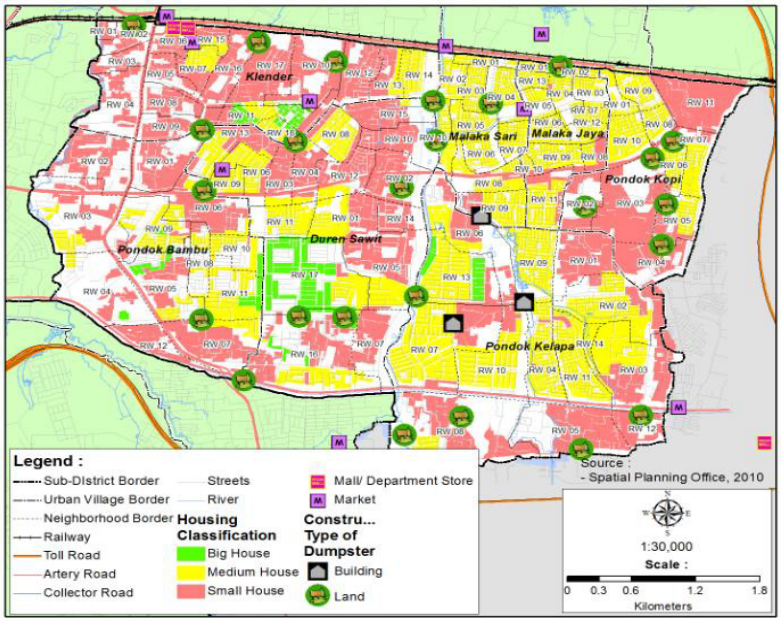

Fig. 2 The map of the location of the temporary landfills and the housing area at Duren Sawit District

From Fig. 2, it is seen that the 28 temporary locations do not separate evenly on the seven villages. Therefore, if looked within one kilometer radius from the temporary landfills service area, there are some areas which lack of the facilities. The shortage of temporary landfills area has made people throw their household waste in the illegal area/property. This area is called a shadow temporary landfills area because there is no registered list on the Sanitation Department. These shadow temporary landfills add more problem to the environmental issues, such as land/air/water pollution and health issue. The more volume of the unmanaged waste, the more disease brought to the people who live around the temporary landfills area. Based on the questionnairres on the 100 KK, the respondents said that they get sick more due to the unmanaged waste.

The household waste composition data are not available at district level. The Statistical Office only has the household waste composition for the national level. For the system dynamics analysis, this paper refers to the data as presented on Table 3. If compared with other countries, Indonesia has 60% of organic waste, Thailand has 46% of organic waste, Europe (average) has 25.4% of organic waste, Japan has 11.7% of organic waste, and USA has 12 % of organic waste (Yeoh, 2006). If the organic waste is more than 50%, it means that the consumption pattern is still

on the food. It means that the probability of the household spending on the food is bigger than 30%. Implicitly, it indicates that the level of the economic development is still low.

Table 3. Waste Characteristic at DKI Jakarta Province 2010

Type	Percentage (%)
Organic	55.37
Inorganic	44.63
Paper	20.57
Plastic	13.25
B3	1.52
Other	9.29

Source: Sanitation Department DKI Jakarta Province.

The waste management system in Indonesia still includes the activities: (a) the waste is collected; (b) the waste is thrown into the trash bin or hang up in front of the front door; (c) the sanitation officer will carry the waste into the temporary landfills; and (d) the dump truck will carry the waste to the permanent landfills. The main problem here is that even though Waste Management is regulated under Law No. 18/2009 for Waste Management, there is no law enforcement and no punishment-rewards systems. On the other hand, the society participation in separating the waste into the organic and inorganic categories has not been conducted thoroughly. Therefore, reduction of the waste from the source (from the household) does not work well.

The unmanaged waste at Duren Sawit District is shown in Table 4. The reference data range from 2007 to 2011, and the simulation for the BAU is until 2020.

Table 4. Population Number and Waste Volume at Duren Sawit District

Year	Population	Waste Production/Day (m^3)	Unmanaged Waste (m^3)
2007	320,925	868.19	556.50
2008	321,991	874.00	862.00
2009	323,449	874.00	695.00
2010	375,596	874.00	415.00
2011	376,819	944.00	484.00

Source: Statistical Office and Sanitation Department.

From the CLD, the Stock Flow Diagram (SFD) for the System Dynamics analysis is presented in Fig. 3:

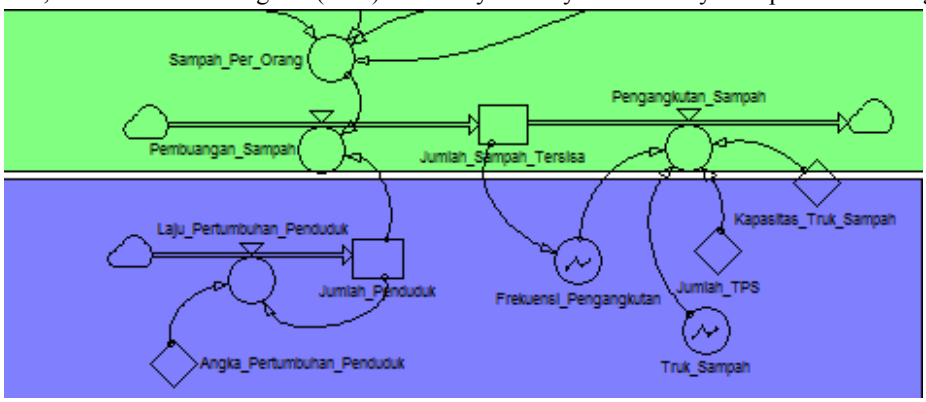

Fig. 3. Stock Flow Diagram (SFD) the Waste Management SystemSource: System Dynamics Analysis, 2014.

The data validation run valid for the population number (jumlah_penduduk), household waste disposal (pembuangan_sampah), and transporting household waste (pengangkutan_sampah). The functional intervention is based on the statistical analysis for each sub-variables. The Absolute Means Error (AME) for those variables are below 30%, so all variables are valid. The SFD with the intervention can be seen in Fig. 4.

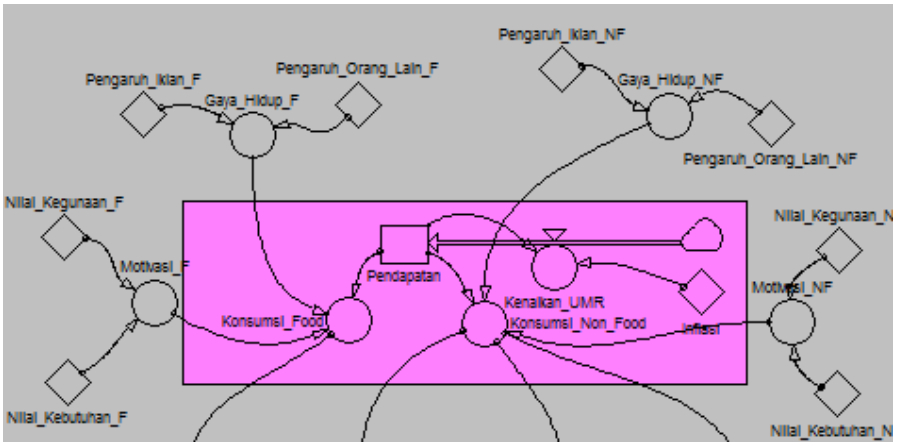

Fig. 4. SFD with the Intervention Model
Source: System Dynamics Analysis, 2014.

The intervention (e.g. F is for Food and NF is for Non-Food) on the following sub-variables: on the needs value (=nilai_kebutuhan), the usage value (=nilai_kegunaan), motivation (=motivasi), lifestyle (=gaya_hidup). The variables are: food consumption (=konsumsi_food), non-food consumption (=konsumsi non-food), and income (=pendapatan). The household income is approached using the minimum wage (=kenaikan_UMR) with the inflation rate (=inflasi).

The sensitivity test results for the sub-variables show that the need value and the advertisement for food consumption are relatively sensitive compared with other sub-variables. We can crosscheck this result with the result from the in-depth interview where people got more information for on-the-go products for food consumption. For example, the ready food and drinks for practical purposes. Finally, to reduce the unmanaged waste, people's motivation should be improved through advertisement related with the environmental value. Green motivation and green lifestyle will be more sustainable in the future to reduce the household waste.

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